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Exploring the Impact of Digital Competence and Technology Acceptance on Academic Performance in Physical Education and Sports Science Students

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Abstract

Aim/Purpose	This study aims to examine the influence of digital competences, technology acceptance, and individual factors (gender and educational level) on academic achievement in Physical Education and Sports Science (PESS).
Background	Prior research has established a positive correlation between digital competences and performance, but the mediating role of technology acceptance remains unclear. Furthermore, there is no evidence in the literature about this relationship among students pursuing degrees in PESS.
Methodology	A survey was administered to 344 students pursuing degrees in PESS. The Students' Digital Competence Scale (SDiCoS) measured digital competences, while

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the Technology Acceptance Model (TAM) assessed technology acceptance. Academic performance was evaluated based on students' GPAs.

Contribution This paper investigated the role of digital competence within the TAM framework and its influence on academic performance. We propose that digital competence variables positively impact students' intention to use digital tools for learning. This aligns with TAM principles, where intention and attitude toward technology predict its actual use. Our findings further strengthen the understanding of TAM by confirming strong connections between perceived ease of use, perceived usefulness, and attitude toward technology. Additionally, the study suggests that digital competence and frequent device usage patterns might be more prevalent in postgraduate education.

Findings The investigation supports the link between digital competences and technology acceptance in PESS students. Specifically, TAM variables, particularly attitudes and intentions regarding technology use, significantly predicted these students' academic performance. Interestingly, no direct association was found between SDiCoS digital competences and academic performance. Digital competence variables were positively associated with students' intention to use digital tools for learning. Gender differences emerged, with females reporting higher academic performance and proficiency in Communicate, Collaborate, and Share (CCS) competences. Furthermore, postgraduate students reported digital competences, higher academic performance, stronger intentions to use technology, and more frequent utilization of laptops/tablets.

Recommendations for Practitioners Educators, administrators, and policymakers should consider targeted interventions and curriculum development to enhance academic performance in the fields of physical education and sports science. Specifically, strategies should focus on fostering digital competences in areas relevant to the field while addressing gender-specific needs.

Recommendations for Researchers Future research should further explore the nuanced relationship between digital competences, technology acceptance, and academic performance, with a focus on refining the predictive efficacy of TAM variables and examining the role of individual factors, such as motivation and self-efficacy.

Impact on Society The findings have implications for improving academic outcomes in PESS, ultimately contributing to the development of a highly skilled and technology-literate workforce in this field.

Future Research Future research should examine the specific mechanisms through which digital competences and technology acceptance influence academic performance to develop effective interventions and strategies.

Keywords academic performance, digital competence, physical education, sports science, technology acceptance

INTRODUCTION

In the rapidly evolving digital landscape of today's world, digital literacy has gained growing significance for university students. Digital technologies not only provide students with access to information and resources, but they also offer new and innovative ways to learn and engage with course material (Timotheou et al., 2023). However, the extent to which students benefit from digital technologies depends on their beliefs about digital competence and their acceptance of using these technologies (Scheel et al., 2022). Still, different university disciplines have different requirements for the use of digital technologies. This research article will explore the associations between digital competence, technology acceptance, and academic performance of Physical Education and Sports Science (PESS) students. The investigation of the cognitive constructs that underlie students' attitudes toward digital tools is expected to provide a nuanced understanding of the interplay between technological beliefs and academic achievement, providing valuable insights for educators, administrators, and policymakers alike.

Digital competence reflects a set of skills, knowledge, and attitudes that enable the use of technologies and underpin learning, work, and active participation in society (Spante et al., 2018), while newer competence frameworks incorporate the importance of values in responsible and ethical technology use. In addition, digital competence involves other essential skills such as critical thinking, problem-solving, and creativity (Van Laar et al., 2017). As universities increasingly incorporate digital technologies into their curricula and learning environments, students' digital competence levels play a pivotal role in their academic success (Sánchez-Caballé et al., 2020). Digital competence empowers students to become active participants in the learning process, fostering self-directed learning and enabling them to take ownership of their education.

Literature Review

Digital competence and its impact on academic performance

Numerous studies underscore the pivotal role of digital competence in shaping academic success and influencing online learning outcomes. Even the leisurely use of the internet, such as for entertainment purposes like music, films, and social media, has been identified as positively contributing to academic performance, as evidenced by the findings of Mishra et al. (2014). Murtadho et al. (2023) further highlighted the relationship between higher levels of digital literacy among high school students and enhanced capabilities in learning, collaborating, and navigating challenges in the digital era.

The impact of digital literacy on academic performance is not limited to high school. Ukwoma et al. (2016) reported that Nigerian students perceived digital literacy as a factor influencing their academic achievements. Cabero-Almenara et al. (2023) found that students from a wide range of university disciplines who had to repeat the academic year demonstrated an inferior level of digital competence across all questionnaire-assessed dimensions compared to those with no history of repeating a course. Mehrvarz et al. (2021) uncovered a positive effect of students' digital competence on both digital informal learning and academic performance. The study further identified informal learning as a mediating variable positively influencing the relationship between digital competence and academic performance. Similarly, Heidari et al. (2021) established the mediating role of digital informal learning between digital competence and academic engagement.

Digital competence extends its influence on achievement-related indicators. Kim et al. (2018) revealed a positive association between digital competence and learning agility, which subsequently positively impacted course engagement among students from various academic disciplines, including humanities, social sciences, natural sciences, engineering, and medicine. Moreover, this positive association persisted during the COVID-19 lockdowns, as indicated by Limniou et al. (2021), who found that psychology and veterinary students with high digital capabilities maintained higher concentration and engagement and demonstrated superior performance in challenging circumstances.

Technology Acceptance Model and performance

The Technology Acceptance Model (TAM) (Davis, 1986), which is a commonly utilized theoretical framework that explains user acceptance of technology, is an important and closely related research area. Technology acceptance can refer to understanding its capabilities and the willingness to learn and embrace technology for personal or professional gain. TAM and its extended versions TAM2 and TAM3 (Venkatesh & Bala, 2008; Venkatesh & Davis, 2000), as well as the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) have been widely used over the years to explain the adoption of various technologies, such as personal computers, mobile phones, e-commerce websites, and software applications in a variety of settings. According to Davis (1986), users' intentions to use technology are determined by two key factors: perceived usefulness and perceived ease of use. Perceived usefulness is defined as the extent to which a user believes that using a technology will enhance their performance. Perceived ease of use refers to the user's perception of how easy it is to use the technology. The model posits that these two factors jointly influence user attitudes towards a technology, which then determines actual usage.

Several empirical studies have tested the validity of the TAM. Most of these studies have found support for the model and observed significant relationships between perceived usefulness, perceived ease of use, and user intentions or behaviors. The TAM has effectively determined students' attitudes towards e-learning (Rafiq et al., 2020). These findings suggest that the TAM can be used to accurately predict user attitudes and behaviors regarding technology. Furthermore, past studies suggest that there is a relationship between the TAM and student performance. Galy et al. (2011) found that factors such as perceived usefulness, perceived ease of use, and the ability to work independently were significant predictors of business and administration students' final grades. Hanham et al. (2021) also found that the perceived usefulness of technology was positively associated with academic self-efficacy, which in turn was positively associated with academic achievement in students from diverse university disciplines (e.g., arts and social sciences, business studies, computing, engineering, mathematics, education, law, nursing, psychology). Similarly, Navarro et al. (2023) discovered that the perceived usefulness of technologies directly impacted perceived learning, and perceived ease of use of technologies had a direct effect on academic performance. Ali et al. (2018) found that perceived usefulness and ease of use had a significant influence on cloud computing adoption, which, in turn, positively impacted academic performance for university students.

Digital competence and technology acceptance

Students with strong digital competences are more likely to embrace technology for learning. Previous studies have shown that university students' digital competence, including information and data literacy, communication and collaboration, digital content creation, safety and security, problem-solving, and analyzing and reflecting, positively influence the perceived ease of using digital technologies for learning (Scheel et al., 2022). Similarly, Liao et al. (2018) found a correlation between computer self-efficacy among technological university students and the perceived usefulness and ease of use in e-book production. In line with this, the digital competence of university students was related to their intention to adopt technology for online higher education distribution (Le et al., 2022). The digital competence of pre-service teachers affected their intention to use digital learning materials for teaching (Paetsch & Drechsel, 2021), their use of digital technology for English learning as a second language (Sulistiyo et al., 2022), perceived usefulness and subjective norm, technological complexity (negative impact), and perceived ease of use (Milutinović, 2022), as well as informal learning attitude, intention, and actual use (He et al., 2021; He & Li, 2019; He & Zhu, 2017; He et al., 2018) in students from a wide range of university disciplines.

However, some studies show conflicting results. For instance, Lai et al. (2012) found that computer self-efficacy may not always translate to a positive perception of learning technology's usefulness. Additionally, Joo et al. (2018) discovered that while Technological Pedagogical Content Knowledge (TPACK) impacts self-efficacy and perceived ease of use in educational settings, it might not directly influence the intention to use technology.

The need for digital competences varies across different educational disciplines. For example, students in fields like informatics or engineering naturally require stronger digital skills due to the frequent use of digital tools. Unfortunately, many past studies haven't explored these differences. Often, these studies don't mention the students' field of study, or they group students from various disciplines together. For example, Heidari et al. (2021) found that undergraduate and graduate students' digital competence positively and significantly correlated with students' digital informal learning and academic engagement. Similarly, Sayaf et al. (2022) investigated the adoption of digital learning technology in teaching and learning by undergraduate and graduate students from arts and humanities, medical science, and computer science. They found that students' basic computer abilities, media-related abilities, and web-based skills had a substantial influence on perceived usefulness and perceived ease of use. In addition, Scheel et al. (2022) found that university students' (from various fields) digital competences positively influenced their acceptance of digital learning. Furthermore, Thi et al. (2023) found that students' attitudes, information technology ability, and self-study ability impacted their intention to accept online learning.

Only a few previous studies explicitly investigated the digital competence of students in specific educational disciplines. For example, Terzis and Economides (2011) found that computer self-efficacy positively impacted perceived ease of use for computer-based assessments in introductory informatics courses. Martzoukou et al. (2020) identified a perceived lack of digital competence in areas like information literacy and digital identity management among library and information science students. Similarly, Niu et al. (2022) found that a surface learning approach negatively correlated with digital competence in English as a Foreign Language (EFL) courses.

Recent research highlights the importance of examining digital competence within specific disciplines. Paetsch and Drechsel (2021) found that pre-service teachers' self-reported improvements in digital skills significantly influenced their intentions to use digital learning materials. Similarly, Milutinović (2022) found that pre-service teachers' digital nativity positively influenced their intention to use technology in the future classroom. Tzafilkou et al. (2022) found significant differences in digital competence scores between postgraduate students in digital marketing (highest) and undergraduate programs in e-commerce (lowest). Similarly, Ahmed (2023) linked computer self-efficacy in business students to their self-directed learning behavior. Studies on teachers also reveal this trend. Tzafilkou et al. (2023) documented that informatics teachers reported the highest digital competences, while those in literature, foreign language, and primary education reported the lowest.

The same goes for subject-specific competences, with informatics/engineering/technology teachers reporting higher augmented reality competences than science or language teachers (Nikou et al., 2023). Vieira et al. (2023) found biology and geology teachers scored higher in digital competence compared to physics and chemistry teachers, who themselves scored higher than mathematics and natural sciences teachers. Limniou et al. (2021) found differences between psychology and veterinary students, which they attributed to the curriculum and the demands of each program.

This growing body of research suggests a significant link between digital competence, technology acceptance, and academic performance across various disciplines. However, a gap exists in PESS. Limited research has investigated this area despite the increasing demand for digital competences in PESS fields.

There is a clear need for research that investigates the effects of digital competence and technology acceptance on the academic performance of physical education students. This knowledge gap is particularly concerning in the rapidly evolving digital age, where students of PESS departments require a robust set of digital competences to effectively navigate their academic and professional landscapes. Research in PESS has explored areas such as health, gamification, and wearable technologies that all require high digital competences. Jastrow et al. (2022) advocated that better training and preparation of PESS students is required to establish the appropriate digital competence. The curriculum of PESS programs often focuses heavily on practical courses developing motor skills or specific sports (e.g., football, athletics). While science courses are included, a large portion of the curriculum revolves around these practical activities. This raises the question of whether PESS students, compared to students in other disciplines, require the same level of digital competence in their everyday university life.

This study aims to address this gap by examining the association between digital competence, technology acceptance, and academic performance among students in PESS. In essence, this paper investigates the influence of digital competences, technology acceptance, and individual factors (gender and educational level) on academic achievement. It aims to clarify the mediating role of technology acceptance and provides insights into enhancing academic outcomes through targeted interventions.

Research questions

In line with existing theory and literature, we investigated the following research questions:

RQ1: Does students' digital competence positively affect their intention to use technology?
RQ2: How do technology acceptance factors like attitude (RQ2a) and intention (RQ2b) influence the academic performance of physical education students?
RQ3: Within the TAM, are there: Significant relationships between attitude and intention to use digital competence (RQ3a)? Attitude and actual use of technology (RQ3b)? Intention to use digital competence and actual use of technology (RQ3c)? Perceived ease of use and attitude towards digital competence (RQ3d)? Perceived usefulness and attitude towards digital competence (RQ3e)?

The framework presented in Figure 1 depicts all the variables and the expected relationships, providing a visual representation of the research model.

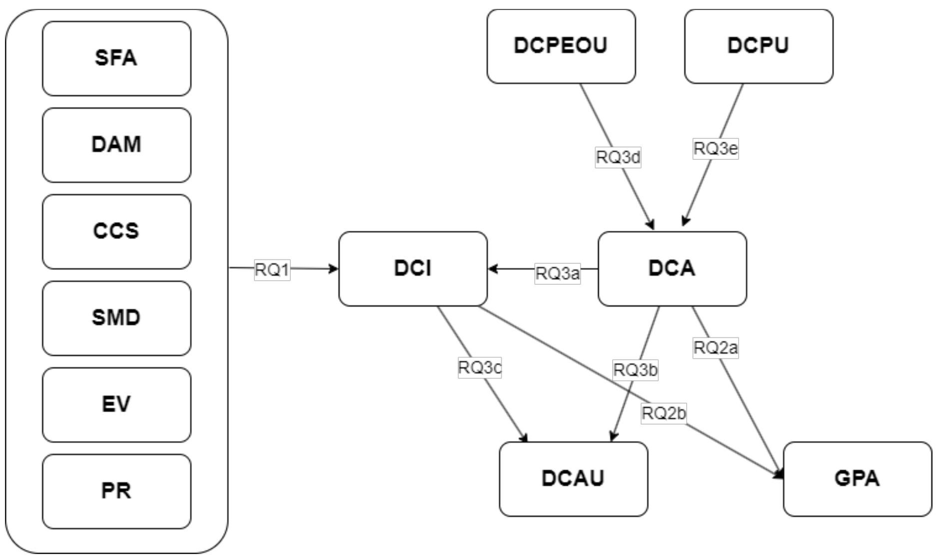

Figure 1. The research model-relationships between digital competence, technology acceptance, and academic performance

Note: SFA = Search, Find, Access, DAM = Develop, Apply, Modify, CCS = Communicate, Collaborate, SMD = Store, Manage, Delete, EV = Evaluate, PR = Protect, Share, DCPEOU = Perceived Ease of Use, DCPU = Perceived Usefulness, DCA = Attitude, DCI = Intention, DCAU= Actual Use, GPA = Grade Point Average (academic performance)

Research has shown that there is a gender difference in digital competence and technology acceptance, with males generally outperforming females (Qazi et al., 2022; Vázquez-Cano et al., 2017). Furthermore, younger adults tend to be more digitally competent and accepting of technology than older adults (Goodman-Deane et al., 2021; Hauk et al., 2018). Lastly, existing evidence indicates that the more people use computers, the more digitally competent they are likely to become (Ghomi & Redecker, 2019; Lucas et al., 2019; Martinez-Lopez et al., 2020).

Thus, in addition to the research questions above, we investigated how digital competence and technology acceptance levels might vary according to gender, age, and hours of mobile and laptop/tablet use. To explore these relationships, we formulated the following research questions:

RQ4: Do technology acceptance variables differ significantly between different groups of students based on their digital competence and academic performance?

RQ5: Is there a significant difference in digital competence and technology acceptance levels between genders (e.g., do males report higher levels compared to females)?

RQ6: Are there significant differences in digital competence and technology acceptance among different age groups (e.g., do younger students report higher levels compared to older students)?

RQ7: Do student groups who use mobile and laptop/tablet devices more frequently demonstrate significantly different levels of digital competence and technology acceptance (e.g., does higher usage lead to higher digital competence and technology acceptance)?

METHOD

PARTICIPANTS AND PROCEDURE

A total of 344 students were involved in this study, comprising 170 males and 173 females (one participant did not reveal gender). Of these, 308 (89%) were undergraduate students attending 14 different units in levels 1-4 at the Department, with a mean age of 20.8 years (*SD* = 4.1) and included 158 males and 149 females. The remaining 36 students (11%) were postgraduate students attending two units in the MSc program, averaging 34 years of age (*SD* = 9.3), with 12 males (33%) and 24 females (67%). The gender distribution, with fewer male postgraduate participants, aligns with the typical ratio seen in our universities, rendering the sample acceptable.

The study employed a non-probabilistic convenience sampling approach within the population of PESS students, encompassing both undergraduate and postgraduate students from the Department of PESS. Recruitment occurred during the Spring semester of 2023 through regular departmental classes. Prospective participants were invited to take part in the study voluntarily and anonymously. They were briefed on the study's purpose and required to provide written consent to proceed. The survey was administered using a Google form to ensure privacy. Participants were assured that their responses would remain accessible only to the research team.

This research obtained permission from the Ethics Committee of the Department of PESS of the Aristotle University of Thessaloniki. All participants were informed about the objectives and procedures of the study and furnished written informed consent before their involvement. The study's procedures and measures were meticulously crafted to protect the anonymity of the participants and the confidentiality of their responses.

MEASURES

Demographic data collection encompassed social and academic information, including gender, age, and self-reported grade point average (GPA) from the previous semester. It's important to note that in Greek Universities, GPA is measured on a scale from 0 (low) to 10 (high). Additionally, participants reported the hours spent using mobile phones, tablets, and computers or laptops per day.

Perceived digital competence among students was assessed using the Students' Digital Competence Scale (SDiCoS). The scale, developed by Tzafilkou et al. (2022), comprises 28 items measured on a five-point Likert scale, ranging from "Strongly disagree" to "Strongly agree." The scale aims to evaluate students' digital competences, covering six components: Search, Find, Access (SFA), Develop, Apply, Modify (DAM), Communicate, Collaborate, Share (CCS), Store, Manage, Delete (SMD), Evaluate (EV), and Protect (PR). Example items, respectively, include "I can navigate in the real-world using the advanced features of a navigator," "I can create a document with text, diagrams, tables, reports, and advanced formatting," "I can collaborate with people using various smart devices, platforms, and digital tools," "I can download content and save it directly to the relevant folder," "I can evaluate whether an email is spam, adware, phishing, or fraud," and "I can regularly change my passwords and settings of my smart devices and Internet accounts."

To assess students' technology acceptance, items from the TAM were employed. These included scales measuring Perceived Usefulness, Perceived Ease of Use, Attitudes, and Intention, with each scale consisting of three items. Participants indicated their level of agreement with each item using a five-point Likert scale, ranging from "Strongly disagree" to "Strongly agree." Example items included "Digital competences are useful for my studies," "It is easy to apply digital competences," "Digital competences are necessary to perform well in my studies," and "I intend to use digital competences for academic tasks," respectively.

Furthermore, participants reported their frequency of digital competences usage over the previous month, week, and a typical day. Specifically, they rated, on a five-point Likert scale ranging from "Very rarely" to "Very often," how frequently they utilized digital competences. They also reported how many hours per day they used their mobile device and their PC or tablet.

The scales underwent rigorous validation for both reliability and validity within the current student population. Content validity was ensured through expert reviews involving three experts specializing in Technology Enhanced Learning who reviewed and finalized the wording. An Exploratory Factor Analysis (EFA) was carried out on the TAM scale to confirm its structural validity, particularly as the items were translated and adapted to align with the context of perceived acceptance of digital competences. The EFA verified the predetermined factors, explaining 56% of the variance, with factor loadings ranging from .58 to .99.

In addition, a Confirmatory Factor Analysis (CFA) was conducted on both scales to evaluate the convergent validity of all constructs. The Partial Least Squares (PLS) algorithm was applied with a factor weighting scheme, employing 300 iterations to derive factor loadings, Composite Reliability (CR), and Average Variance Extract (AVE) values. According to Hair et al. (2019), factor loading estimates should be higher than 0.5 and, ideally, 0.7 or higher. To meet the factor loading threshold of 0.7, four constructs were removed from the initial SDiCoS scale (CCS1, SMD3, SMD4, PR1) because they were less significant, as per Hair et al. (2019). Hence, the final instrument was composed of the remaining 12 components. The questionnaires demonstrated satisfactory convergent validity, with CR and AVE values for each factor surpassing .70 and .50, respectively, aligning with previous research standards (Dijkstra & Henseler, 2015; Fornell & Larcker, 1981). Internal consistency and reliability were validated through CR, Cronbach's alpha, and the Dijkstra-Henseler Rho_A coefficient (Dijkstra & Henseler, 2015). The SDiCos and TAM items are listed in Appendix A (Tables A1 and A2).

DATA ANALYSIS

Descriptive statistics, including means and standard deviations, were calculated for all study variables. Pearson correlation analysis was used to assess the relationships between the SDiCoS components and the TAM dimensions, providing correlation coefficients at a 95% confidence interval to gauge the strength and direction of these relationships. For comparative analysis across various groups, such as male and female students or undergraduate and graduate students, one-way analysis of variance (ANOVA) was employed. This allowed for comparisons involving TAM and SDiCoS components, reported academic performance, gender, academic level, frequency of digital competences use, and hours of mobile and desktop/tablet device usage per day. To investigate whether TAM and SDiCoS components could predict reported academic performance, Structural Equation Modelling (SEM) analyses were conducted. The model fitness was based on indices of Root Mean Square Error of Approximation (RMSEA) (Bandalos, 2018; Browne & Cudeck, 1992).

The data analysis involved utilizing SPSS software for descriptive statistics, correlation tests, variance tests, and EFA. CFA for the two scales was conducted using SmartPLS 4.

RESULTS

DESCRIPTIVE STATISTICS AND ASSOCIATIONS BETWEEN TAM AND SDICOS COMPONENTS

Table 1 displays the means, standard deviations, and correlations among the study variables. The correlation analysis revealed strong associations within the SDiCoS components as well as within the TAM dimensions. However, it is important to note that the correlations between the SDiCoS components and the TAM dimensions were not statistically significant.

Table 1. Correlation analysis and descriptive statistics of the study variables

	SFA	DAM	CCS	SMD	EV	PR	DCPU	DCP-EOU	DCA	DCI	DCAU	Mob-Use	PC-Use	GPA
SFA		.60**	.68**	.74**	.68**	.57**	.00	-.03	.02	-.07	-.01	-.01	.19**	.16**
DAM			.71**	.63**	.64**	.07	-.01	.04	-.03	.05	-.06	.18**	.12*	.16**
CCS				.75**	.67**	.04	-.00	.04	-.02	.06	-.04	.16**	.15**	.14*
SMD					.75**	-.02	-.00	.03	-.02	.01	-.05	.19**	.21**	.21**
EV						.05	-.04	-.02	-.08	-.03	-.07	.10	.14*	.14*
PR							.05	-.01	.05	-.03	.05	.01	.12*	.16**
DCPU								.52**	.71**	.47**	.02	.01	-.00	.02
DCPEOU									.44**	.57**	.45**	-.00	-.04	-.07
DCA										.71**	.50**	.04	.02	.02
DCI											.56**	.03	-.02	-.02
DCAU												.08	.07	.09
MobUse													.17**	.09
PCUse														.11*
GPA														
Mean	3.99	3.18	3.84	4.01	3.68	3.50	4.18	3.73	4.12	4.11	3.56	4.21	1.63	7.55
SD	.74	.90	.85	.86	.76	.93	.79	.84	.77	.81	.98	1.81	1.77	1.01

Note: * $p < .05$; ** $p < .01$ (2-tailed); SFA = Search, Find, Access, DAM = Develop, Apply, Modify, CCS = Communicate, Collaborate, Share, SMD = Store, Manage, Delete, EV = Evaluate, PR = Protect, DCPU = Perceived Usefulness, DCPEOU = Perceived Ease of Use, DCA = Attitude, DCI = Intention, DCAU= Actual Use, MobUse = Mobile Use per Day, PCUse = PC/Tablet Use per Day, GPA = Grade Point Average (academic performance)

VALIDITY OF THE MEASUREMENT MODEL

The measurement model and coefficient paths can be visualized in Figure 2. The construct reliability and validity of the model were assessed by CR (minimum value of .70, according to Gefen et al., 2000), Cronbach's alpha (minimum value of .60, according to Hair et al., 2006), and AVE (minimum value of .50, according to Bagozzi and Yi (1988). The factor loadings were assessed based on their reliability score, which was greater than .50, according to Hulland (1999).

As depicted in Table 2, the constructs have Cronbach's alpha and CR values above .70, indicating good internal consistency. Additionally, AVE values are above .5, suggesting acceptable convergent validity. These results indicate that the measurement model demonstrates adequate reliability and convergent validity for all the constructs.

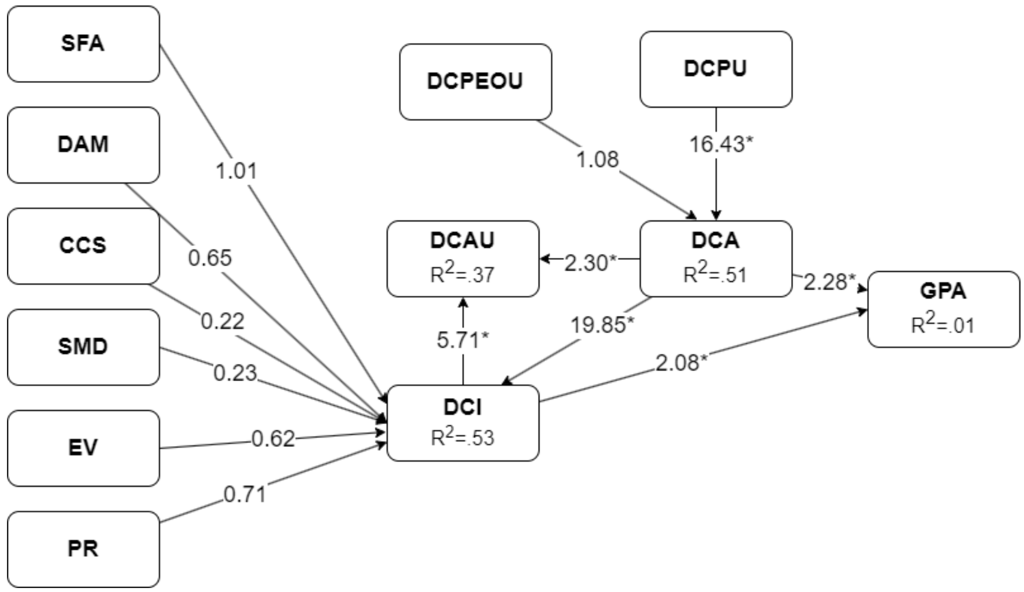

Figure 2. Structural equation model paths among variables

Note: SFA = Search, Find, Access, DAM = Develop, Apply, Modify, CCS = Communicate, Collaborate, Share, SMD = Store, Manage, Delete, EV = Evaluate, PR = Protect, Share, DCPEOU = Perceived Ease of Use, DCPU = Perceived Usefulness, DCA = Attitude, DCI = Intention, DCAU= Actual Use, GPA = Grade Point Average (academic performance)

Table 2. Construct reliability and validity of the model

	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
SFA	.84	.88	.60
DAM	.73	.88	.79
CCS	.80	.81	.60
SMD	.80	.79	.57
EV	.85	.89	.57
PR	.79	.73	.51
DCPEOU	.85	.93	.87
DCPU	.87	.92	.80
DCA	.85	.91	.76
DCI	.87	.92	.80
DCAU	.85	.91	.77

Note: SFA = Search, Find, Access, DAM = Develop, Apply, Modify, CCS = Communicate, Collaborate, Share, SMD = Store, Manage, Delete, EV = Evaluate, PR = Protect, Share, DCPEOU = Perceived Ease of Use, DCPU = Perceived Usefulness, DCA = Attitude, DCI = Intention, DCAU= Actual Use

The extent to which our measures capture distinct constructs was assessed using various methods presented in Appendix B. Discriminant validity, which ensures our measures capture distinct constructs, was assessed by comparing the square root of AVE for each construct with the correlations between the latent variables. According to the Fornell and Larcker (1981) criteria, discriminant validity is confirmed if the square root of the AVE for each construct is greater than the correlation between that construct and any other construct in the model. The criteria were met for all constructs, indicating that the latent variables in our PLS model are sufficiently distinct from each other (see Table B1). Additionally, the heterotrait-monotrait ratio of correlations (HTMT) was applied to further evaluate discriminant validity, demonstrating accepted values (<.90), according to Franke and Sarstedt (2019), for most constructs (see Table B2). The Variance Inflation Factor (VIF) was examined, revealing values lower than the critical threshold of 3.3 (Ramayah et al., 2018) for all items (see Table B3).

STRUCTURAL MODEL

The structural model was evaluated based on the path coefficients and the R^2 values, where path coefficients were greater than .10 with t-values greater than 1.96 at a significance level of .05. Table 3 presents the *t*- and *p*-values that were extracted through the bootstrapping procedure as well as the descendent constructs' R^2 values. As presented in the table, the PLS model explains approximately 50.7% of the variance in attitudes, 36.7% of the variance in actual use, 52.7% of the variance in intentions, and approximately 1.1% of the variance in academic performance.

Overall, the results of the structural model indicated that GPA was directly affected by the students' digital competency attitude and their intention to use digital competences. Attitude also affected the students' digital competencies, actual use, and intention, while intention also affected actual use. Finally, the students' perceived usefulness of digital competences and perceived ease of use significantly affected their attitude.

Table 3. PLS results for variances and relationships among variables

	Mean	SD	R^2	*t*-value	*p*-value
DCA			.51		
DCAU			.37		
DCI			.53		
GPA			.01		
CCS -> DCI	0.00	0.05		0.22	.83
DAM -> DCI	0.02	0.05		0.66	.51
DCA -> GPA	0.14	0.06		2.29	.02*
DCA -> DCAU	0.19	0.08		2.31	.02*
DCA -> DCI	0.71	0.04		19.92	.00*
DCI -> GPA	-0.14	0.07		2.09	.04*
DCI -> DCAU	0.46	0.08		5.74	.00*
DCPEOU -> DCA	0.06	0.05		1.09	.28
DCPU -> DCA	0.68	0.04		16.45	.00*
EV -> DCI	-0.06	0.06		0.62	.53
PR -> DCI	-0.01	0.07		0.72	.47
SFA -> DCI	-0.06	0.06		1.01	.31
SMD -> DCI	0.02	0.05		0.23	.82

Note: * = support. DCA = Attitude, DCAU = Actual Use, DCI = Intention, GPA = Grade Point Average (academic performance), CCS = Communicate, Collaborate, Share, DAM = Develop, Apply, Modify, DCPEOU = Perceived Ease of Use, DCPU = Perceived Usefulness, EV = Evaluate, PR = Protect, SFA = Search, Find, Access, SMD = Store, Manage, Delete

Differences Between Student Groups

Levene's test for homogeneity of variance was performed on the gender-based student groups. The results indicated that the test for homogeneity did not reach statistical significance ($p > .05$), allowing for the application of ANOVA tests. A one-way ANOVA was executed to compare the responses of female and male students concerning TAM and SDiCoS variables, reported academic performance, and the hours of mobile and desktop/tablet usage. The analysis unveiled significant differences specifically in the SDiCoS component of CCS, $F(1, 335) = 3.36$, $p < .005$, showcasing higher scores among girls ($M = 4.08$, $SD = 0.67$) compared to boys ($M = 3.51$, $SD = 1.10$). Moreover, significant differences were observed in academic performance $F(1, 335) = 9.42$, $p < .001$, with girls reporting higher grades ($M = 7.80$, $SD = 0.68$) than boys ($M = 7.30$, $SD = 0.85$).

A one-way ANOVA was conducted to compare the responses of both undergraduate and graduate students to TAM and SDiCoS variables, digital competency usage, academic achievement, frequency of digital competences usage, and mobile and desktop/tablet utilization. The analysis unveiled noteworthy differences in the TAM component of intention to use digital competences (DCI) $F(1, 335) = 4.92$, $p < .005$, and digital competences actual use (DCAU) $F(1, 335) = 7.35$, $p < .001$. Postgraduate students exhibited higher scores in both components (DCI: $M = 4.40$, $SD = 0.84$; DCAU: $M = 3.99$, $SD = 0.94$) compared to undergraduates (DCI: $M = 4.08$, $SD = 0.81$; DCAU: $M = 3.51$, $SD = 0.98$). Similarly, the analysis indicated significant differences in the daily hours of desktop or tablet use between educational levels (undergraduate and postgraduate), $F(1, 342) = 34.86$, $p < .001$. The mean daily hours of desktop or tablet use for undergraduate students ($M = 1.44$, $SD = 1.58$) was lower than for postgraduate students ($M = 3.19$, $SD = 2.42$). There were no differences in daily hours of mobile use $F(1, 342) = 0.12$, $p > .05$. Finally, postgraduate students reported superior academic achievement $F(1, 325) = 73.55$, $p < .001$ ($M = 8.78$, $SD = 0.57$ compared to $M = 7.40$, $SD = 0.95$).

Discussion

Digital competences are paramount for university students in today's rapidly evolving academic landscape. Mastery of digital tools and technologies empowers students to effectively navigate the digital realm, enabling them to conduct in-depth research, collaborate seamlessly with peers, and present information in innovative ways (Wang et al., 2021; Zhao et al., 2021). Additionally, these competences are vital for online learning platforms and digital resources that have become integral parts of modern education. Moreover, possessing a strong foundation in digital competences equips students for future careers, as virtually every industry now relies on technology for various aspects of their operations (Musarat et al., 2023). This study aimed to contribute to our understanding of the relationships between digital competences, technology acceptance, and academic performance, as well as the potential influence of individual factors on these variables in PESS undergraduate and postgraduate students.

The TAM variables had a significant influence on reported academic performance. For the entire student sample, two of the TAM variables (i.e., attitudes and intentions) demonstrated a significant, although small, predictive power for reported academic grades. These findings indicate that attitudes and intentions toward technology acceptance, as defined by TAM, directly translate into tangible improvements in academic achievement. This is in line with the theory of planned behavior, suggesting that attitudes and intentions are among the most important predictors of human behavior (Ajzen, 2020). On the other hand, the usefulness and ease of use were not found to influence academic performance in PESS students. This might be especially true for the study sample. Our participants were studying PESS. According to the university curriculum, most of the lessons involve physical practice in common sports or attending lectures. Thus, the usefulness of digital tools for the successful completion of studies is rather limited. Furthermore, the assessment of the students in these lessons does not require digital competences as they largely rely on demonstrating the methodology to teach sports skills, performing the sports skills, and passing written exams based on a given textbook. The lack of required digital tools in their studies suggests the students in our sample might not use them frequently.

The results of the analysis revealed non-significant associations between the dimensions of SDiCoS and their beliefs about digital competences (TAM) and academic performance. The findings are in line with Joo et al. (2018) but contradict studies like Liao et al. (2018) and Lai et al. (2012), who provided evidence that digitally competent students would report more positive attitudes, higher ease of use and usefulness of the digital tools and ultimately higher intentions to use them in their studies. A plausible explanation might be that these constructs represent distinct aspects of technology-related behaviors. In this sense, digital competence may be differentiated from accepting the use of technology for academic purposes. Another explanation may lie in the study sample, i.e., PESS students, and the nature of the content and assessment methods used in this discipline, as described above. Students may be digitally competent for recreational reasons but may have disentangled their digital competence beliefs from their academic life. Still, further research is warranted to attest to this assumption in other university samples.

When examining gender differences, the results indicated no statistically significant differences between male and female students in their responses to the TAM scale. This suggests that both male and female students share similar digital competences and report similar beliefs about their use during their studies. Differences were found only for the SDiCoS component of CCS, with girls reporting higher scores, which may indicate a potential gender-specific proficiency in utilizing digital platforms for social interaction and collaboration. This finding aligns with previous research highlighting that females tend to engage more actively in online social environments (e.g., social media and online forums) and are generally more inclined towards digital communication (Baumgartner et al., 2014). This heightened proficiency among girls in digital social competence may be attributed to various social and cultural factors that encourage greater emphasis on communication skills in female socialization. Furthermore, this finding may be reflective of broader societal trends in the utilization of digital technology. For example, it has been observed that girls tend to be early adopters of social media platforms, using them as a means of maintaining social connections and nurturing relationships (Herring & Kapidzic, 2015).

Significant differences were observed in digital competences based on educational levels. This result is in line with Perifanou et al. (2021), who found that postgraduate students expressed significantly higher values than undergraduate students in the components of CCS, EV, PR, and DAM. Postgraduate students demonstrated higher scores in both DCI and DCAU compared to their undergraduate counterparts. This difference may be attributed to the increased demand for digital competences in postgraduate studies, which often involve more extensive research and written assignments.

Postgraduate students reported more daily hours of desktop or tablet use but not mobile use. While undergraduate students appear to use their mobile devices equally, the key distinction lies in desktop or tablet usage. This suggests a potential correlation between increased desktop or tablet use and academic tasks, particularly essay writing, which is more prevalent among postgraduate students.

Engaging in online lectures, delivering presentations, conducting literature reviews, and writing essays all require a certain level of proficiency in utilizing various platforms and databases. Consequently, postgraduate students appear to have a greater need for digital competences compared to their undergraduate counterparts, who primarily attend practical or theoretical courses.

The observation that postgraduate students use laptops aligns with the notion that they may be involved in more intensive academic activities requiring such devices. In contrast, undergraduates may not need laptops as extensively, possibly because their assessments may not heavily emphasize tasks that necessitate the use of desktops or tablets. These findings suggest a link between a higher level of education and a stronger emphasis on and proficiency in digital competences.

In summary, these findings shed light on the nuanced patterns of technology use among students of varying educational levels. The observed differences in desktop or tablet usage imply a potential link to academic tasks, highlighting the need for further exploration into the specific academic activities driving these disparities.

IMPLICATIONS

Students who are proficient in digital competences are better able to interact with digital resources, navigate digital learning environments, and generate academic work of a high quality, all of which contribute to increased academic achievement. While this study focused on PESS students, the influence of technology acceptance on academic performance suggests broader implications for policy makers, education administrators, and educators across all disciplines.

To cultivate a positive learning environment that embraces technology, educational institutions should implement strategies to promote digital fluency among students, educators, and staff. Through training, they can develop the expertise to effectively utilize technology.

Universities should prioritize fostering strong digital competences in all students, regardless of their major. This can be achieved by offering dedicated courses and workshops on digital skills, or by integrating technology into existing curricula. Universities should consider revising curricula to ensure they adequately prepare students for the digital demands of future careers, regardless of their chosen field.

Technology offers a powerful tool for personalized learning experiences. By integrating technology into teaching, learning, assessment, and support services, educators can cater to individual needs based on factors like gender, discipline, and ability level. Equitable access to digital infrastructure, tools, and educational resources is crucial to bridge the digital divide and ensure all students benefit from technology-integrated learning. Effective technology-mediated learning hinges on the seamless integration of digital tools and skills into classrooms and assignments.

However, educators themselves must possess the necessary digital competences. Therefore, educational institutions should offer appropriate training, support, and professional development opportunities for educators so they can leverage technology effectively in their teaching. Furthermore, providing educators with access to appropriate digital infrastructure, tools, and educational resources is essential to facilitate effective digital teaching and learning practices. Collaboration with libraries and technology departments can be particularly beneficial in this regard.

The observed gender difference in communication and collaboration skills suggests a need for initiatives encouraging female students to engage actively in online environments. Universities and instructors can create opportunities for collaboration in online platforms that leverage female students' strengths in communication and social interaction. Encouraging female students to mentor and support each other in developing and utilizing digital tools could further bridge this gap.

The findings regarding increased digital competence among postgraduate students highlight the need for programs that cater to their specific needs. Integrating more digital tools and tasks into assessments can encourage students to develop stronger digital skills while aligning instruction with contemporary demands.

To effectively integrate digital tools into curricula or utilize technology for promoting active learning and engagement, universities should thoroughly consider various factors, including educational discipline requirements, educational goals, students' digital competence levels, educators' digital competence levels, available infrastructure, resources, and more. Consequently, the following steps could be undertaken:

1. Conduct a needs analysis and set goals to ascertain the requirements for digital competences, infrastructure, and tools on the educational subject, as well as the current and anticipated digital competences of students and educators.

2. Provide training and support to both students and educators regarding digital competences, infrastructure, tools, and educational materials.
3. Develop interactive multimedia educational resources and serious games to enhance engagement and learning experiences.
4. Facilitate synchronous and asynchronous communication and collaboration among students and educators using digital tools.
5. Implement student-centered teaching, learning, and assessment methods (such as inquiry-based, problem-based, project-based, collaborative, active, and authentic learning) utilizing digital tools.
6. Offer personalized teaching, learning, assessment, and feedback tailored to individual student needs.
7. Foster the development of 21st-century skills, including creativity, critical thinking, and collaboration, among students through the integration of digital tools and methodologies.

By integrating these recommendations, educational institutions can harness the potential of technology to enhance learning experiences, bridge digital divides, and prepare students for the demands of the digital world, regardless of their chosen field.

CONCLUSION

This study investigated the relationships between digital competence, technology acceptance, and academic performance among PESS students. We found that technology acceptance, which reflects students' attitudes and beliefs about technology's usefulness and ease of use, significantly impacts academic achievement. This highlights the importance of fostering positive technology acceptance alongside developing digital competences. No direct link was found between digital competence and academic performance. This suggests that simply possessing digital competences may not be enough; students also need to believe in the usefulness and ease of using technology for academic purposes. This highlights the need to bridge the gap between skill possession and practical application. Postgraduate students demonstrated higher levels of digital competence and stronger technology acceptance compared to undergraduates. This highlights the importance of considering educational background in the interpretation of responses regarding digital competences and emphasizes the need for educational programs to cater to the evolving digital needs of students at different stages of their academic journey, potentially by bridging the gap between acquired skills and practical application.

Our findings make several key contributions to the field of PESS. We addressed a gap in the literature by investigating the relationship between digital competences and academic performance specifically within this discipline. Additionally, we extended the TAM to this field, confirming its predictive power for academic outcomes. Furthermore, by revealing gender differences in CCS competences, our study offers valuable insights for educators and policymakers. These findings translate to actionable recommendations: educators can tailor instruction to different needs based on gender and educational background, while policymakers can develop programs that enhance digital competences and promote technology acceptance across student groups.

This study acknowledges several limitations. Self-reported measures of digital competence might introduce bias. Self-assessment and knowledge/competences quizzes have been used to show the gap between perceived and real ability in other studies (Kruger & Dunning, 1999). Students may have overstated their competence in some areas, especially in areas where it is not typically expected, and this might have distorted the data. The study was conducted before the widespread release of AI tools; hence, AI use was not included as a potential variable in the present study. The focus on PESS students limits generalizability. This subject requires attendance of practical courses on sports and may not offer the same possibilities and challenges for digital competences as other university subjects. Despite these limitations, we examined the digital competences of students in a particular department of a European public university.

Future research may compare students' digital competences across similar or different departments, universities, countries, cultures, educational systems, and languages, given the limited previous research in this area. This could involve diverse students from different educational disciplines. Additionally, it would be beneficial to explore these relationships across various disciplines using objective measures of competence. The impact of emerging technologies like artificial intelligence on student learning holds significant promise for further exploration. Future studies may also investigate the effect of enhancing students' digital competences on their academic behavior, academic performance, and other 21st-century skills. Finally, conducting longitudinal studies that track the evolution of students' digital competences over time could provide valuable insights.

Despite its limitations, this study sheds light on the role of digital competence and technology acceptance in academic success. It encourages educational institutions to prioritize fostering these skills in students across all disciplines, preparing them for the increasingly digital demands of future careers and academic endeavors.

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CONFLICT OF INTEREST

Nothing to disclose.

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Appendix A. Instruments Used in the Study

Table A1. SDiCoS items

SFA	I can search and find a specific object or similar objects using various search engines (e.g., Google, Yahoo, Bing) and databases, using appropriate keywords and advanced criteria and filters.
	I can search and find a specific person on various social networks using various techniques and filters (e.g. various formats of name, photo, email address, school, company, etc.)
	I can search and find groups on a specific topic (e.g., hobby, profession, artist, science, historical event, travel destination) on various social media.
	I can navigate in the real world using the advanced features of a navigator.
	I can watch (read, listen, view) content in various formats on various smart devices.

DAM	I can create an event and set notifications using a digital calendar (e.g., Google Calendar, Apple Calendar, Microsoft Outlook Calendar).
	I can creatively design and/or develop a website using various digital tools (e.g., Wix, WordPress)
	I can create a document with text, diagrams, tables, reports, and advanced formatting
	I can apply Creative Commons licenses to content or software that I have created.
	I can apply statistical techniques using appropriate software (e.g., SPSS, R, MS Excel, Google Sheets) to make forecasting or predictions.
	I can convert content from one format to another format.
CCS	I can teach an e-course or an e-seminar, give a lecture or make a presentation using various digital tools.
	I can upload and share software or apps that I have developed on various social media.
SMD	I can take a photo or a video and save it in various formats (mp4, wmv, avi, qt, gif, jpg, etc.) using various smart devices and digital recording tools
	I can download content and save it directly to the relevant folder.
	I can organize the files on my computer into a hierarchical folder structure.
EV	I can evaluate an object and/or a smart device using appropriate quality criteria (e.g., authenticity, utility, ease of use, appearance, functionality, enjoyment).
	I can critique an object and/or a smart device on relevant social media (e.g., TripAdvisor, YouTube, Amazon).
	I can evaluate whether some information is a hoax, fake, scam, or fraud.
	I can evaluate whether a website is secure and trusted.
	I can identify the intellectual property rights (IPRs) of content that I have found on the Internet.
	I can evaluate whether an email is spam, adware, phishing, or fraud.
PR	I can protect various smart devices and e-accounts using different passwords and frequently changing them.
	I can protect myself and others against identity theft, harassment, bullying, or slander.

Note: SFA = Search, Find, Access, DAM = Develop Apply Modify, CCS = Communicate, Collaborate, Share, SMD = Store, Manage, Delete, EV = Evaluate, PR = Protect

Table A2. TAM items

DCPU	Digital competences are useful for my studies.
	Digital competences improve my performance in classes.
	Digital competences boost my effectiveness.
DCPEOU	Digital competences are simple and easy to use.
	It's easy to apply digital competences.
	It's easy to use digital competences to do what I need to do in my studies.
DCA	It is necessary to have digital competences to perform well in my academic studies.
	I know that digital competences can help me perform better in my academic studies.
	Digital competences are an important part of my development during my academic studies.
DCI	I intend to use digital competences to prepare me for classes and exams.
	I intend to use digital competences for my academic activities.
	I intend to use digital competences as often as possible in the future.

Note: DCPU = Digital Competences Perceived Usefulness, DCPEOU = Digital Competences Perceived Ease of Use, DCA = Digital Competences Attitude, DCI = Digital Competences Intention

Appendix B. Model Fit Statistics

Table B1. Discriminant validity of the measurement model

	GPA	CCS	DAM	DCA	DCAU	DCI	DCPEOU	DCPU	EV	PR	SFA	SMD
GPA	1											
CCS	.07	.77										
DAM	-.08	.46	.88									
DCA	.04	-.00	-.02	.87								
DCAU	-.04	.04	.00	.51	.87							
DCI	-.03	-.04	-.04	.71	.59	.89						
DCPEOU	-.05	-.03	-.05	.40	.45	.54	.93					
DCPU	.03	-.00	.02	.71	.49	.68	.50	.89				
EV	.05	.57	.50	-.02	-.03	-.09	-.04	.01	.75			
PR	.04	.33	.47	-.00	-.04	-.07	-.00	.00	.57	.71		
SFA	.06	.60	.39	.00	-.01	-.07	-.04	-.00	.68	.40	.77	
SMD	.05	.47	.27	-.01	-.02	-.05	-.01	-.02	.53	.32	.57	.75

Table B2. Heterotrait-monotrait ratio of correlations (HTMT)

	CCS	DAM	DCA	DSAU	DSI	DSPEOU	DSPU	EV	GPA	PR	SFA	SMD
CCS												
DAM	.94											
DCA	.52	.41										
DSAU	.60	.64	.63									
DSI	.61	.53	.82	.70								
DSPEOU	.78	.75	.49	.56	.64							
DSPU	.60	.47	.81	.60	.78	.57						
EV	.76	.68	.32	.38	.44	.69	.42					
GPA	.14	.16	.19	.27	.15	.12	.19	.03				
PR	.85	.87	.27	.40	.39	.70	.33	.81	.09			
SFA	.86	.76	.40	.57	.54	.79	.51	.78	.16	.67		
SMD	.94	.83	.48	.64	.59	.72	.50	.70	.19	.72	.88	

Table B3. Variance inflation factor

Model items	Variance inflation factors (VIF)
CCS2	1.60
CCS3	1.80
CCS4	1.71
CCS5	1.27
DAM1	1.97
DAM2	1.49
DAM3	1.60

Model items	Variance inflation factors (VIF)
DAM5	1.59
DSA1	1.82
DSA2	2.12
DSA3	2.10
DSAU1	1.96
DSAU2	2.25
DSAU3	2.10
DSAU4	1.00
DSI1	2.52
DSI2	2.34
DSI3	2.10
DSPEOU1	2.28
DSPEOU2	3.00
DSPEOU3	2.22
DSPU1	2.17
DSPU2	2.64
DSPU3	2.33
EV1	1.38
EV3	1.92
EV4	1.93
GPA	1
PR2	1.41
PR3	2.04
PR4	2.14
PR5	1.29
SFA1	1.97
SFA2	1.80
SFA3	1.64
SFA4	1.55
SFA5	1.70
SMD1	1.68
SMD2	1.87
SMD5	1.53

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